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Management of swallowing disorders in ICU patients - A multinational expert opinion

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ABSTRACT

Background: Dysphagia is common in intensive care unit (ICU) patients, yet it remains underrecognized and often unmanaged despite being associated with life-threatening complications, prolonged ICU stays and hospitalization.
Purpose: To propose an expert opinion for the diagnosis and management of dysphagia developed from evidence-based clinical recommendations and practitioner insights.
Methods: A multinational group of dysphagia and critical care experts conducted a literature review using a modified ACCORD methodology. Based on a fusion of the available evidence and the panel's clinical experience, an expert opinion on best practice management was developed.
Results: The panel recommends adopting clinical algorithms intended to promote standardized, high-quality care that triggers timely systematic dysphagia screening, assessment, and treatment of extubated and tracheostomized patients in the ICU.
Conclusions: Given the lack of robust scientific evidence, two clinical management algorithms are proposed for use by multidisciplinary teams to improve early systematic detection and effective management of dysphagia in ICU patients. Additionally, emerging therapeutic options such as neurostimulation have the potential to improve the quality of ICU dysphagia care.

1. Introduction

Dysphagia, also referred to as disordered swallowing or deglutition, is defined as an impairment of the swallowing process. It commonly occurs in ICU patients and can stem from multiple etiologies. ICU-acquired swallowing disorders are often multifactorial and secondary to direct trauma, neuromyopathy as part of ICU-acquired weakness, impaired oropharyngeal and laryngeal sensation, impaired cognition and altered level of consciousness, gastroesophageal reflux and dis-coordination of breathing and swallowing [1-6].

Independent risk factors for dysphagia in ICU patients include baseline neurologic disease, emergency admission, disease severity, as well as age $\geq$ 65 years old, APACHE II $\geq$15, and duration of tracheal intubation with mechanical ventilation $\geq$72 h [7,8]. Surgical and

Abbreviations: ACV, above cuff vocalization; CRT, cough reflex testing; CSE, clinical swallowing evaluation; FEES, flexible endoscopic evaluation of swallowing; OWV, one way valve; PES, pharyngeal electrical stimulation; RMST, respiratory muscle strength training; VFSS, videofluoroscopic swallowing study.

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medical risk factors include congestive heart failure, sepsis, hypercholesterolemia, increased operative time, and multiple intubations [9]. For emergency ICU admission patients, upon extubation 18% failed a water swallow screening [10] while 41% were confirmed to have post-extubation dysphagia (PED) as judged via instrumental assessment. Of those with PED, 36% silently aspirated [12]. Moreover, up to 93% of patients with a tracheostomy were shown to have swallowing difficulties [11].

Dysphagia has long lasting and severe consequences shown to persist in the majority of ICU patients until hospital discharge, increasing 90-day mortality by 9.2% [10] and one year mortality up to 25% [13]. Complications include higher risk for aspiration and aspiration-induced pneumonia, delayed return of oral intake leading to malnutrition and dehydration, decreased quality of life, prolonged ICU and/or hospital stays, increased morbidity and mortality [1,10,13-20]. Effects are observed in one third of patients and may persist up to 5 years [21,112].

Despite its clinical significance, dysphagia remains underrecognized and unmanaged. While the benefits of systematic screening are evident [10,22], only inconsistent screening and limited relevant recommendations are reported in the critical care literature [23-26]. The only systematic review and meta-analysis that addresses treatment in this population noted limited dysphagia awareness and treatment options [27]. An international survey (528 respondents from 69 countries) showed that only 28% of ICUs use a specific dysphagia-related protocol [28]. This is true even in the highest risk populations. An international multi-center cross-sectional survey of 746 ICUs across 26 countries showed that only 30% of ICUs assessed for dysphagia after 48-h of intubation, 41% after tracheostomy, and 67% after extubation [23,29].

Our aim was to propose evidence- and experience-based clinical algorithms for the management of dysphagia in high-risk ICU patient populations.

2. Material and methods

The study design was based on a modified version of the five-step ACCORD method [30] which involves establishing a multidisciplinary expert panel; conducting a literature review and using the combined expertise of the panel to evaluate the clinical evidence behind each patient interaction; reaching a consensus on best practices; developing formal algorithms that reflect the consensus; and disseminating for clinical use.

Eleven experts representative of the ICU care team were asked to participate in a review of the current evidence. The team included nine physicians and two speech-language pathologists (SLPs). The expert panel represented a broad range of medical specialties including intensivists, neurologists, speech-language pathologists, phoniatrists, and an

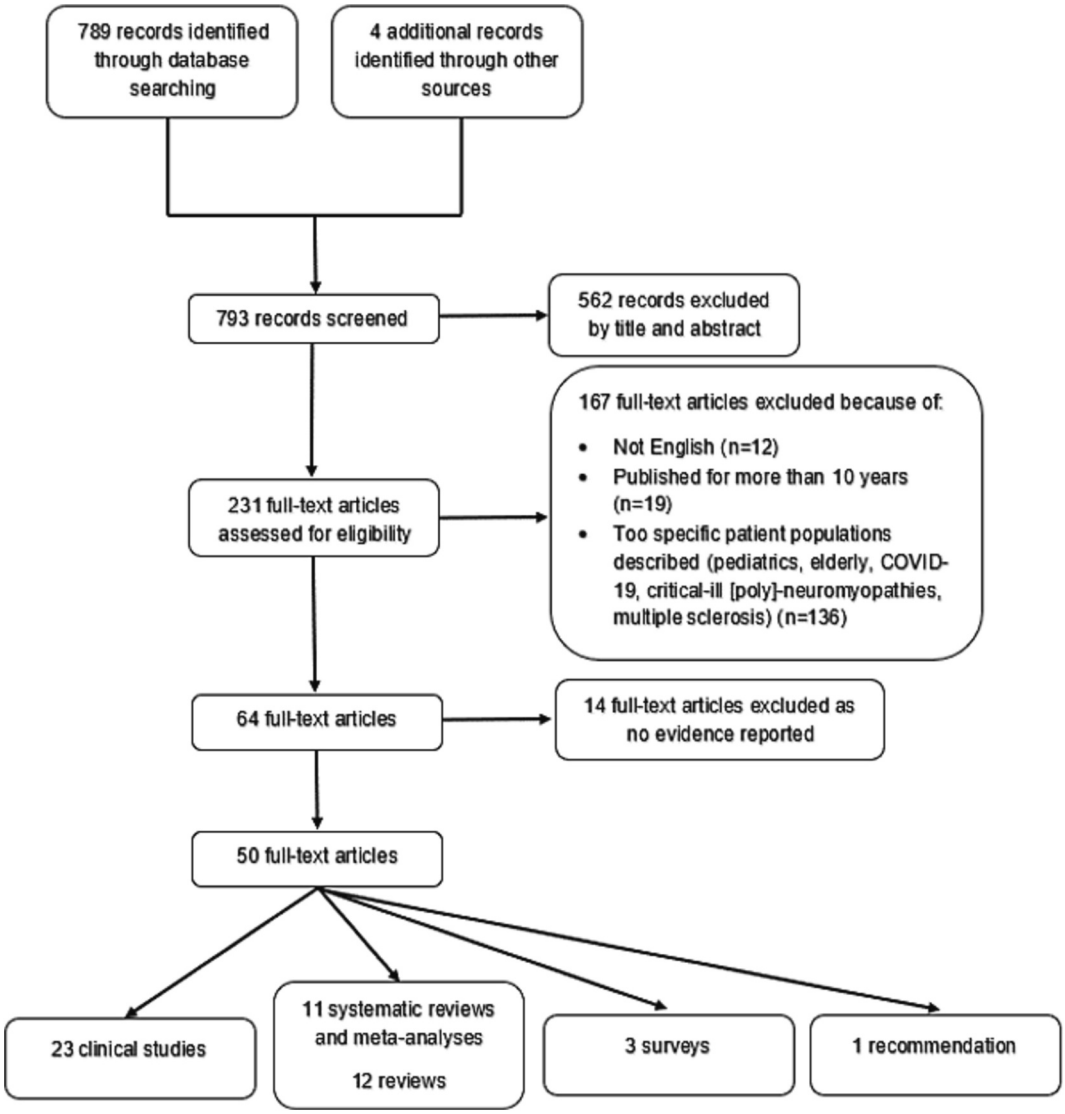
789 records identified through database searching
4 additional records identified through other sources
793 records screened
562 records excluded by title and abstract
231 full-text articles assessed for eligibility
167 full-text articles excluded because of:
Not English (n=12)
Published for more than 10 years (n=19)
Too specific patient populations described (pediatrics, elderly, COVID-19, critical-ill [poly]-neuromyopathies, multiple sclerosis) (n=136)
64 full-text articles
14 full-text articles excluded as no evidence reported
50 full-text articles
23 clinical studies
11 systematic reviews and meta-analyses
12 reviews
3 surveys
1 recommendation

Fig. 1. Algorithm of literature search.

otolaryngologist all of whom work in a combined ten teaching hospitals across three European countries.

Seven hundred and ninety three papers were identified by the panel through literature searches on PubMed between April and July 2022. Search terms, used alone or in combination, included "'dysphagia", "swallowing", "ICU", "intensive care", "critical care", "laryngeal complications", "post-extubation dysphagia", "tracheostomy", "treatment", "critical illness", "rehabilitation", "muscle strength training", "modified diets", "pharyngeal electrical stimulation", "PES", "decannulation", "post extubation" and "intubation". Inclusion criteria were research papers, review papers, meta-analyses, and systematic reviews, papers written in English, and articles that were <10 years old.

Exclusion criteria were any papers that did not meet the inclusion criteria, were not full-text articles, and only pertained to non-representative or specific patient populations (e.g., pediatrics). This excluded seven hundred and twenty nine papers. Another 14 articles were excluded because they lacked reportable evidence. The remaining 50 papers included 23 clinical studies, 11 systematic reviews or meta-analysis, 3 surveys and one recommendation paper (Fig. 1).

These 50 papers were reviewed unblinded by the entire panel (the same rules applied throughout the review process and agreements made via open discussion with the group) and graded as to the quality of their evidence using the grading system outlined by Harbour and Miller [31]. This comprised of a methodological evaluation (e.g., study design, conduct, reliability) of each paper to determine a quality rating. The study type combined with the assessment of methodological quality was then used to determine the level of evidence it provided. Clinical recommendations were generated based on expert recommendations from the panel after the initial review of the literature. (Tables 1–4) Recommendations were then reviewed by the group and discussed, both in person and virtually, until a unanimous consensus was reached. All recommendations were approved by 100% of the expert panel. Suggested clinical algorithms were constructed to incorporate clinical guidance into a workflow that reflected best practice for post-extubation or tracheostomized patients.

3. Results

The panel of experts arrived at a consensus based on their review of the evidence available in the identified literature and their clinical experience. They unanimously agreed on the importance of having a trained multidisciplinary care team, systematic screening of all ICU patients, use of instrumental assessment in appropriate cases, and early intervention with treatment options tailored to the needs of the patient. A sequence of appropriate steps were organized into two algorithms that reflect the above (Figs. 2 and 3).

3.1. Multidisciplinary care team

Dysphagia management in the ICU requires a multidisciplinary care team that includes critical care intensivists (may also include other physicians, e.g. neurologists, gastroenterologists, physiatrists), dysphagia specialists, nurses and nurse practitioners, and dieticians [3]. Due to variations in local practice, dysphagia specialists may be speech-language pathologists, specialized otolaryngologists known as phoniatrists, occupational therapists, or physiotherapists. Creation of a specialized dysphagia team with trained specialists ensures consistent evaluations by a group with a comprehensive knowledge of the identification and management of swallowing disorders.

3.2. Pre-extubation group

Impaired airway safety and secretion management seem to predict extubation failure more reliably than traditional respiratory weaning criteria and level of consciousness in ICU stroke patients [32]. Limited data for the screening and potential treatment of intubated patients at risk of extubation failure and tracheostomy is emerging. Bedside screening tools such as the Determine Extubation Failure in Severe Stroke [33] and the Stroke-related Early Tracheostomy score [34] may facilitate identification of at risk patients, although their utility remains to be determined in non-stroke patients. By the time of extubation or tracheostomy, the majority of patients will have lost swallowing coordination, sensation, and muscle mass; therefore, early identification and treatment are critical in minimizing complications. With regards to treatment, evidence is emerging that suggests pharyngeal electrical stimulation (PES) in intubated stroke patients may improve swallowing and health economic outcomes [35,36]. In addition to PES, two other neurostimulation techniques have been reported in intubated patients; pre-emptive swallowing stimulation [37] and neuromuscular electrical stimulation [38]. However, given the current limited body of evidence for the evaluation and treatment of pre-extubation patients, this population is not included in the proposed algorithms.

3.3. The clinical management algorithms

The algorithms (Figs. 2 and 3) begin with an assessment of the

Table 1
Dysphagia screening methods.

Methods	Description	Evidence level*	Recommendation level*	Sensitivity & specificity	Publications
Water swallow test	Yale Swallow Protocol	1+	A	Sensitivity = 96.5 to 100% Specificity = 48.7 to 64%	Leder et al. (2019) [22] Leder & Suiter (2014) [88] Suiter et al. (2014) [40] Suiter & Leder (2008) [89]
	Post Extubation Dysphagia Screening Tool	2+	C	Sensitivity = 81% Specificity = 69%	Johnson et al. (2018) [41]
	Bernese-ICU Dysphagia Algorithm	2+	C	Awaiting formal validation	Zuercher et al. (2020) [42] Schefold et a. (2017) [10]
Multi-consistency screening	GUSS-ICU revised	2+	C	Sensitivity = 89 to 92% Specificity = 67 to 89%	Troll (2022) [43] Troll (2023) [90]
	modified Volume-Viscosity Swallow Test	2+	C	Extubated: Sensitivity = 89.5% Specificity = 72% Tracheostomized: Sensitivity = 100% Specificity = 78.8%	modified Volume-Viscosity Swallow Test: Martínez de Lagrán Zurbano (2023) [113] Volume-Viscosity Swallow Test: Riera et al. (2021) [44] Rofes et al. (2014) [91] Clave et al. (2008) [92]

* Harbour and Miller 2001 [31].

Table 2
Therapeutic diets, compensatory strategies, and postural modifications.

Methods	Description	Evidence level*	Recommendation level*	Publications
Modified diet/fluids with postural and positioning changes and compensatory maneuvers	Diet and fluid texture modifications via the International Dysphagia Diet Standardization Initiative (IDDSI) Framework [61] and use of postural and positioning changes (e.g., chin tuck, head turn) and compensatory maneuvers (e.g., supraglottic swallow) may be considered for patients who are able to manage varying degrees of oral intake with the goal to compensate for specific disordered swallowing physiology to achieve adequate safety and efficiency. The implementation of these behavioral swallowing interventions requires active engagement and consistent follow-through of the patient.	2-	C	Hansen et al. (2022) [93] Speyer et al. (2022) [94] Guénard-Lampron et al. (2021) [95] Hadde and Chen (2021) [96] O'Keeffe (2018) [97] Bath et al. (2018) [98] Beck et al. (2018) [99] Geeganage et al. (2012) [107]

* Harbour and Miller 2001 [31].

Table 3
Targeted rehabilitative interventions.

Additional treatment options for consideration	Description	Evidence level*	Recommendation level*	Publications
Respiratory muscle strength training	Rehabilitative behavioral exercises such as respiratory muscle strength training (e.g., expiratory and inspiratory muscle strength training) are designed to facilitate cough effectiveness, swallowing outcomes, and ventilator weaning. The ability to actively participate in expiratory or inspiratory muscle strength training including number of repetitions and the duration and intensity of treatment sessions will greatly depend on the patient's medical stability, cognitive status, endurance, and stamina.	2++	B	Balcerak et al. (2022) [101] Speyer et al. (2022) [94] Mancopes et al. (2020) [102] Templeman & Roberts (2019) [103] Brooks et al. (2019) [104] Wang et al. (2019) [105] Bath et al. (2018) [98] Langmore & Pisenga (2015) [56] Troche (2015) [100] Laciuga et al. (2014) [106]
Swallowing exercises/maneuvers	Rehabilitative behavioral exercises such as swallowing exercises (e.g., tongue strengthening exercises) and maneuvers (e.g., supraglottic swallow) are designed to improve patient specific physiologic impairment(s). Swallowing exercises and maneuvers are tailored to the patient's individual swallowing impairment(s) based upon instrumental assessment findings to improve short- and long-term swallowing function. The ability to actively participate in these rehabilitative exercises including the exercise type, number of repetitions, and the duration of treatment sessions will greatly depend on the patient's medical stability, cognitive status, endurance, and stamina.	2-	C	Balcerak et al. (2022) [101] Speyer et al. (2022) [94] Bath et al. (2018) [98] Langmore & Pisenga (2015) [56] Geeganage et al. (2012) [107]
Tracheostomy weaning (cuff deflation and tracheostomy occlusion), also referred to as laryngeal weaning	These interventions are specific to tracheostomized patients and include cuff deflation and/or occlusion of the artificial airway which may include digital (finger) occlusion, one way valve placement, or tracheostomy capping. The goal of tracheostomy occlusion is to re-establish airflow to the upper airway to improve swallowing function, as well as smell/taste and voice/speech. Minimal patient involvement is required.	2-	C	Skoretz et al. (2020) [11] Wallace et al. (2022) [58]
Above cuff vocalization (ACV)	This intervention is specific to tracheostomized patients who are unable to tolerate cuff deflation with a goal to restore laryngopharyngeal airflow by applying continuous or intermittent airflow via the subglottic port of a tracheostomy tube allowing vocalization and re-establishment of oropharyngeal and laryngeal sensation. ACV requires patient cooperation and coordination of vocalization efforts.	2-	C	Mills et al. (2022) [108] Wallace et al. (2022) [58]

* Harbour and Miller 2001 [31].

Table 4
Interventional dysphagia therapy – pharyngeal electrical stimulation.

PES publications	Study name	Patient population	Study type	Study phase	Evidence level	Recommendation level*	n	Swallowing related outcomes	Health economic outcomes
Suntrup (2015) [74]		Stroke + tracheostomized	Independent prospective RCT	II	1+	A	30	Decannulation was possible in 75% of patients in the active PES group within 72 h of treatment versus 20% of patients in control group ($p < 0.01$). No recannulations.	
Muhle (2017) [71]		Stroke + tracheostomized	Independent single arm prospective observational study	IV	2+	C	23	Decannulation was possible in 61% of patients who received PES within 72 h of treatment. No recannulations. Increased Substance P (SP) levels post-PES was closely related to treatment success; decannulation with 79% of successfully treated patients showing increase in SP, whereas 89% of unsuccessfully treated patients had stable or decreased SP levels.	
Dziewas (2018) [82]	PHAST TRAC	Stroke + tracheostomized	Multicenter, international prospective RCT	II	1++	A	69	Decannulation was possible in 49% of patients in the active PES group 24–72 h following PES treatment versus 9% in the sham group ($p = 0.00082$). No recannulations.	Median LOS after treatment was 14 days in treatment responders vs 36 days in non-responders ($p = 0.0006$).
Bath (2020) [83]	PHADER	Mixed population + tracheostomized	Multicenter, international single arm prospective observational study	IV	2++	B	158	Improvement was seen in all three DSRS categories of fluids, diet, and supervision, both overall and in each diagnostic group. When assessed in pre-defined subgroups, the reduction in DSRS was greater in participants with shorter times from onset to treatment and duration of ventilation than those with longer time. Similar recovery to DSRS was seen for clinical dysphagia when assessed using the FOIS (which increased significantly by 2.9 points across the cohort) and for instrumentally assessed penetration/aspiration scale scores (with PAS falling significantly by 4.1 units) across all participants. In participants who were cannulated at baseline, decannulation was feasible in both supratentorial and	

(*continued on next page*)

Table 4 (*continued*)

PES publications	Study name	Patient population	Study type	Study phase	Evidence level	Recommendation level*	n	Swallowing related outcomes	Health economic outcomes
								infratentorial stroke, and rates did not differ between the two groups.	
Köstenberger (2020) [35]		Mixed ICU population + pre-extubation	Prospective non-blinded interventional study with historical match control group	IV	2+	C	40	First study demonstrating the benefits of PES in intubated ICU patients. Prevalence of pneumonia was higher in the historical control group versus active PES treatment group ($p = 0.00046$). Reintubation was higher in the historic control group than in the PES treatment group ($p = 0.046$). PES was safe.	
Bangert (2023) [109]		Non-neurological: mixed ICU + tracheostomized	Retrospective comparison of a cohort treated with PES + standard of care versus cohort treated with standard of care only	IV	3	C	20	Readiness for decannulation within 7-days was possible in 100% patients treated with active PES + standard of care versus 33% of patients who received standard of care only ($p = 0.009$). Two patients in the PES group required recannulation. Both were deemed unrelated to PES treatment. Improved PAS scores for thin liquids (IDDSI 0) were observed in 100% of the PES group versus 33% of the group who only received standard of care ($p = 0.09$).	
McGrath (2023) [110]		Non-neurological: mixed ICU + tracheostomized	Independent single arm exploratory study	IV	3	D	18	There was a significant improvement in laryngeal function, measured by improved Penetration Aspiration and Secretion Rating Scale scores ($p = 0.004$ and $p = 0.040$ respectively) at 2–4 days post treatment. Eleven of the 18 patients with silent aspiration on initial FEES improved, seven of whom improved to conscious sensation of laryngeal secretions at the final FEES. Patients improved a median of two IDDSI food levels and a	

(*continued on next page*)

Table 4 (*continued*)

PES publications	Study name	Patient population	Study type	Study phase	Evidence level	Recommendation level*	n	Swallowing related outcomes	Health economic outcomes
								median of three IDDSI fluid levels following PES treatment (p = 0.001).	
Suntrup-Krueger (2022) [111]		Stroke + post-extubation	Independent prospective RCT	II	1+	A	60	PES group showed significantly greater improvement of swallowing function after three treatment days compared to sham (FEDSS, 3.3 vs. 4.3 pts., $p < 0.0005$). Consequently, reintubation rate within 120 h from extubation was 13 vs. 33% (p = 0.067) with a pneumonia rate of 60 vs. 83% (p = 0.045). After PES, 73% were able to consume a completely oral diet in the further course, compared to 47% after sham intervention. Time until totally oral nutrition was 4.3 vs. 10.2 days (p = 0.001). In the sham group, 53% were tube dependent at discharge whereas this was only the case in 27% of the PES group.	Length of stay after study inclusion was significantly shorter after PES (13.8 vs. 21.9 days, p = 0.004).
Muhle (2022) [36]		Stroke + pre-extubation	Independent prospective interventional study with historical match control group	IV	2+	C	64	The FEDSS on first FEES after extubation was significantly lower in the PES group (4.31 ± 1.53 vs. 5.03 ± 1.28; p = 0.047). The reintubation rate within 72 h after extubation was significantly lower in patients who were treated with PES (9.4 vs. 34.4%; p = 0.032). Pulmonary infection following extubation was less frequent following the intervention yet did not reach statistical significance (37.5 vs. 59.4%; p = 0.133).	In the PES group, time from extubation to discharge was significantly shorter compared with control group (14.09 ± 11.58 vs 26.59 ± 20.49 days; p = 0.003).
Traugott 2022 [85]		Mixed ICU + tracheostomized	Independent single arm exploratory study	IV	3	D	19	Following the start of PES, 79% patients were successfully decannulated during their hospital stay (mean time to decannulation, 13 days) with 71% decannulated within 15 days after the first	Analysis of hospital-discharged tracheostomized PES-treated (n = 15) versus non-PES-treated patients (n = 16) in same ICU during the same period (August 2017 to February 2020) showed that all

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Table 4 (*continued*)

PES publications	Study name	Patient population	Study type	Study phase	Evidence level	Recommendation level*	n	Swallowing related outcomes	Health economic outcomes
								PES session. No recannulation. Among the surviving patients, 73% experienced a complete restoration of swallowing function and returned to normal oral intake (DSRS = 0 and FOIS = 7), indicating an optimal management of thin fluids and regular diet without supervision by hospital discharge. In total, the nasogastric or PEG-tube could be removed in 87% patients before their discharge from hospital.	PES-treated tracheostomized patients had a shorter mean LOS in the ICU (47 vs 58 days) and at the hospital (109 vs 125 days) compared to non-PES treated patients.

DSRS, Dysphagia Severity Rating Scale; FEDSS, flexible endoscopic dysphagia severity scale; FEES, flexible endoscopic evaluation of swallowing; ICU, intensive care unit; IDDSI, Dysphagia Diet Standardization Initiative; LOS, length of stay; PAS, penetration-aspiration scale; PED, post-extubation dysphagia; PES, pharyngeal electrical stimulation; RCT, randomized controlled trial.

* Harbour and Miller 2001 [31].

patient for alertness and respiratory readiness (e.g., no critically increased respiratory rate). Due to the fluctuating clinical course of ICU patients, patient screenings may need to be repeated frequently during the ICU stay.

A swallow screening is recommended as soon as possible for patients who are alert, able to co-operate, and meet specific swallow screening inclusion criteria. Options for screening extubated patients are a water swallow test [39] or multi-consistency screening [4]. Examples of validated water swallow tests include the Yale Swallow Protocol [40], Post Extubation Dysphagia Screening Tool [41] or Bernese-ICU Dysphagia Algorithm [42]. Multi-consistency screenings studied in ICU patients include the Gugging Swallowing Screen ICU revised [43] or modified Volume Viscosity Swallow Test [113]. Dysphagia screening methods are summarized in Table 1.

Bedside swallow screening options for patients with a tracheostomy are limited. If the patient is awake/alert and demonstrates respiratory readiness, a trial of cuff deflation can be considered. Thereafter, the tracheostomized group and the extubated group follow separate paths.

3.4. Tracheostomized group (Fig. 2)

It is recommended that all tracheotomized patients, regardless of ventilatory status, participate in an in-line or one way valve (OWV) assessment once able to tolerate cuff deflation or a cuffless tracheostomy tube followed by a bedside swallow evaluation (also known as a clinical swallowing evaluation (CSE)) by a dysphagia specialist [45-47]. The CSE ideally includes: a medical chart review, an oral mechanism examination including a cranial nerve assessment, assessment and consideration of the patient's physiological status and vital signs, status of oral care and secretion management skills, cough reflex testing (CRT) [48] where possible, and assessment of bolus trials if deemed clinically appropriate or a limited CSE, absent of oral trials, before an instrumental evaluation is performed. A patient may need further testing if there are concerns regarding swallowing safety and efficiency which cannot be detected (i.e., silent aspiration) during the CSE.

Because of the known limitations of the CSE [49,50], dysphagia assessment is ideally complemented by instrumental testing such as a flexible endoscopic evaluation of swallowing (FEES) or a videofluoroscopic swallowing study (VFSS) [6,14,51-53]. Both FEES and VFSS are gold standard; however, FEES is preferential in the ICU setting as it is more accessible and viable for the critically ill patient. It can be conducted at the bedside and allows for the visual assessment of potential laryngeal injury, secretion management, and sensory testing in addition to liquid and solid bolus trials [1,3,6,54,55].

In case of concerns for dysphagia during the CSE or confirmed dysphagia diagnosis via instrumental assessment, a comprehensive treatment plan should be established based upon the patient's specific swallowing impairment(s) and medical needs. Special considerations include close observation of the patient's medical/health status, alertness and cognition including the impact of sedation, delirium, and agitation levels on their ability to actively participate. Specific to the tracheostomized patient, any potential risk of dislodging the tracheostomy cannula during active treatment needs to be mitigated.

Compensatory techniques are intended to minimize risk and further complications, but may not improve swallowing physiology (e.g., strength, sensation) [1,5,56]. These include elevating the head of the bed, dental brushing with antiseptic rinse and suctioning; as well as patient mobilization as deemed appropriate. Medications may be considered to reduce oral secretions. Diet modification and use of postural and positioning changes and maneuvers are compensatory in nature but swallowing maneuvers (e.g., supraglottic maneuver) may provide some therapeutic benefit. The International Dysphagia Diet Standardization Initiative levels are recommended as a standardized way of naming and describing modified food textures and thickened liquid consistencies [57]. Ongoing use of instrumental assessments might be considered to guide decisions regarding the patient's ongoing diet levels and continued need for positioning changes and maneuvers.

Appropriateness of laryngeal weaning, also known as tracheostomy weaning, to re-establish airflow and air pressures through the upper airway to restore sensory function and possibly reduce aspiration risk [58], should also be assessed and includes use of in-line or OWV trials with cuff deflation or above cuff vocalization (ACV) with cuff inflation. Additionally, changing to a smaller tracheal cannula in a timely manner can be considered if medically appropriate, as this has been shown to

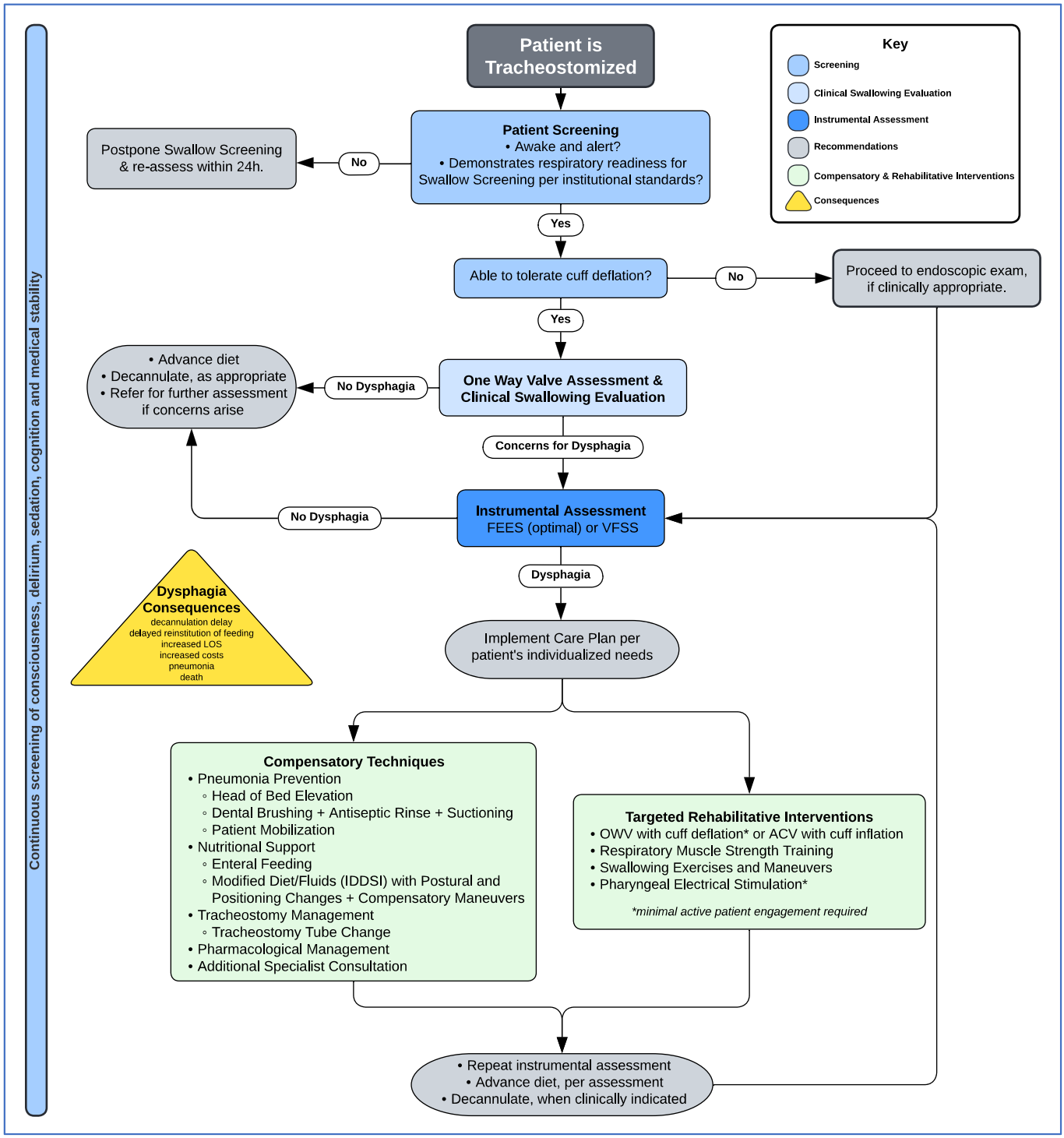

Fig. 2. Clinical pathway for the tracheostomized patient.
ACV, above cuff vocalization; FEES, flexible endoscopic evaluation of swallowing; IDDSI, International Dysphagia Diet Standardization Initiative; LOS, length of stay; OWV, one way valve; VFSS, videofluoroscopic swallow study.

improve tolerance of the one way valve and oral intake significantly sooner [59].

OWV and ACV should only be implemented following upper airway assessment to ensure patient suitability and safety [58]. Requirements for safe and effective OWV use include medical stability, tolerance of cuff deflation, ability to exhale around the tracheostomy tube and through the upper airway, and stable oxygen saturation, respiratory rate, and heart rate while the valve is in place [60]. ACV, which is primarily used for vocalization with cuff inflation, should not be applied before wound healing of the tracheostomy as this may result in emphysema of the neck. Additional contraindications include infection or bleeding at the stoma site, if continuous subglottic suction is required, if the tracheostomy tube is not in an optimal position, or if a patient is unable to cooperate and coordinate vocalization efforts. For the tracheotomized patient, OWV trials may be most appropriate since this requires minimal patient effort. This also applies to patients receiving

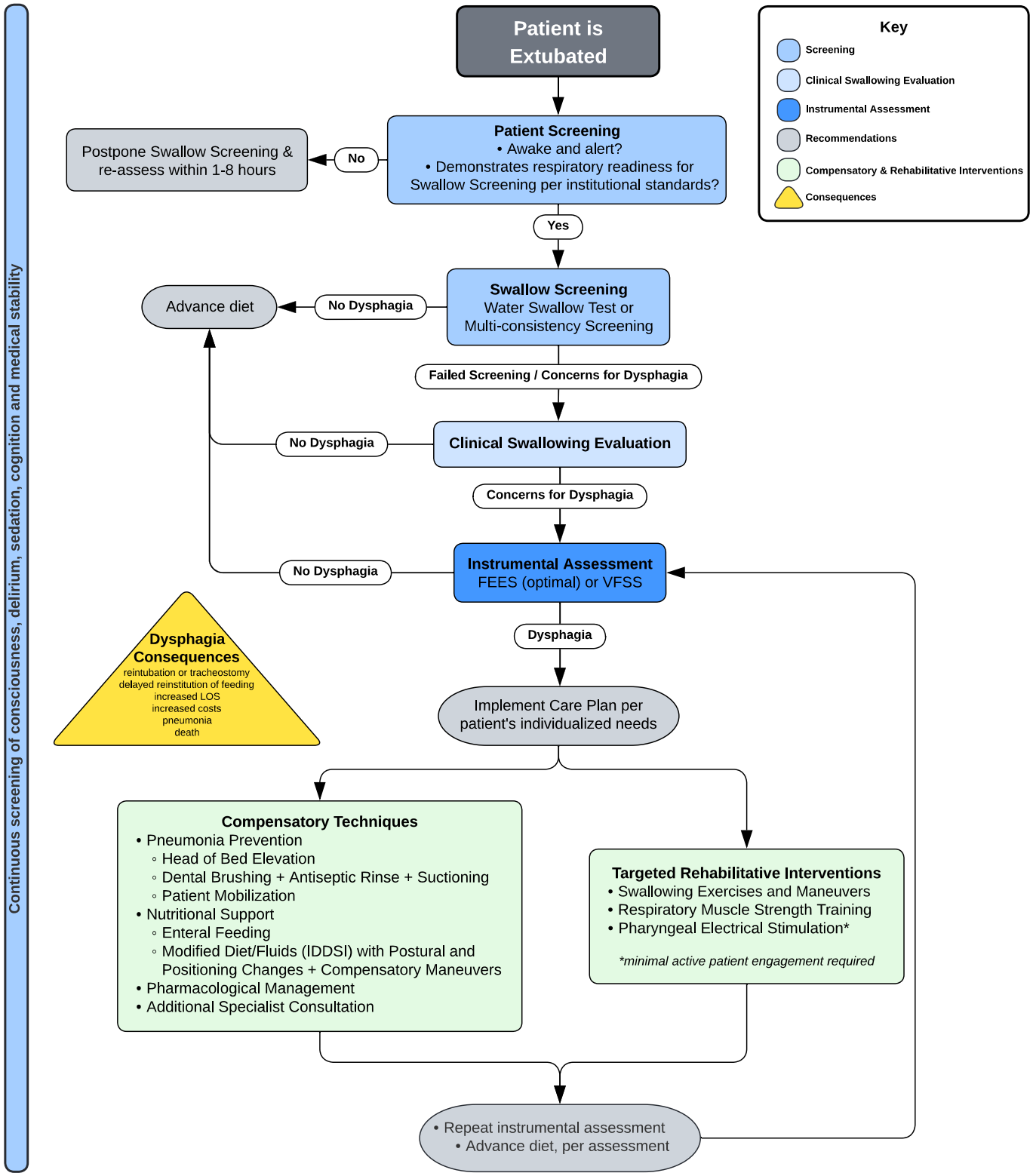

Fig. 3. Clinical pathway for the post-extubation patient.
FEES, flexible endoscopic evaluation of swallowing; IDDSI, International Dysphagia Diet Standardization Initiative; LOS, length of stay; VFSS, videofluoroscopic swallow study.

intermittent spontaneous breathing trials or continuous mechanical ventilation with use of an in-line valve [61].

Other targeted rehabilitative interventions are designed to improve swallowing physiology [1,5,56]. These include respiratory muscle strength training (RMST), swallowing exercises and maneuvers such as the Mendelsohn, and/or novel neurostimulation therapies such as pharyngeal electrical stimulation [1,23,55,62].

PES is a novel neurostimulation technique for the treatment of neurogenic dysphagia [62-66] designed to target and restore the neurological components of swallowing coordination and control that

Compensatory techniques: Designed to minimize the risks of dysphagia

- Head of bed elevation
- Dental brushing, antiseptic rinse, and suctioning
- Patient mobilization as deemed appropriate by physiotherapy, ergotherapy
- Enteral feeding via nasogastric tube or other
- Modified food and liquid diets with use of IDDSI levels
- Postural and positioning changes designed to redirect bolus movement through the oropharynx
- Maneuvers that change the timing or movements of swallowing
- Pharmacologic reduction of secretions (scopolamine, glycopyrroniumbromid and, rarely, Botulinum toxin)
- Additional specialist consultations, such as otolaryngologist or gastroenterologist, as required

Targeted rehabilitative interventions: Designed to improve swallowing physiology

- Tracheostomy weaning including one way valve trials with cuff deflation*
- Above cuff vocalization with cuff inflation (primarily used for vocalization)
- Respiratory muscle strength training
- Swallowing exercises and maneuvers
- Pharyngeal electrical stimulation*

*Therapies that require minimal active patient engagement

Fig. 4. Current therapeutic modalities.

are disrupted due to central (e.g., stroke, traumatic brain injury) or peripheral (e.g., desensitization following prolonged mechanical ventilation) injury [67-74]. PES is one of the only treatment modalities studied specifically in the ICU patient population [27]. As a result, PES has been included in several guidelines for the treatment of neurogenic dysphagia and tracheostomy care [25,75-77]. For the critically ill tracheotomized patient, PES may be an appropriate early intervention given this approach requires minimal patient participation. Fig. 4 lists common treatment options.

Dysphagia treatments should continue for the duration of the patient's hospitalization under the guidance of the dysphagia specialist until the patient reaches their maximum level of functioning. As the patient progresses along their treatment pathway, reassessment for changing needs is suggested. Whenever significant clinical changes are identified, it is recommended that the care team loop back on the algorithm, re-evaluate the patient and alter their specialized treatment plan accordingly. If the patient is improving and meets institutional guidelines for comprehensive decannulation readiness criteria, tracheostomy decannulation may be considered. The Standardized Endoscopic Swallowing Evaluation for Tracheostomy Decannulation can help determine readiness for decannulation as it pertains to secretion management and swallowing function alone [78,79].

3.5. Post-extubation group (Fig. 3)

For the extubated patient, if the swallow screening is failed, it is recommended that a dysphagia specialist complete a comprehensive CSE (as described above) with an optional CRT, where possible, followed by an instrumental assessment, optimally within 24 h.

Similar to the tracheostomized patient, treatment should be implemented based upon the patient's specific swallowing impairment(s), individual capacity to participate, and medical needs. The compensatory techniques and rehabilitative interventions are similar, although tracheostomy tube changes and the use of OWV and ACV will not be applicable. As before, the patient should ideally be followed by the dysphagia specialist until they reach their maximum level of functioning with continued reassessment for changing needs with alteration of the patient's specialized treatment plan as suggested by the algorithm.

If no dysphagia concerns are identified, the medical team may continue monitoring ongoing safe tolerance of oral diet and medications and refer for further assessment if concerns arise.

4. Discussion

Dysphagia in the ICU is common and can stem from multiple etiologies. However, despite its prevalence, dysphagia remains underrecognized and unmanaged with limited dysphagia specialists in the ICU, inconsistent screening, high reliance on non-instrumental bedside assessments, and limited treatment options reported in the literature [23,27,28,29,78]. We aimed two establish a comprehensive clinical algorithms synthesized from the reviewed literature and expert opinion and experience for the early management of extubated and tracheostomized ICU patients.

Moderate to severe post-extubation dysphagia has been shown to be

correlated with pneumonia and in-hospital mortality [79]. Early identification of patients with dysphagia may reduce the risk complications, therefore our algorithms emphasize screening and assessment at the earliest opportunity followed by a treatment plan based upon the patient's individualized needs.

Treatment options are limited in acute and critical care settings [27]. One recently published study demonstrated the efficacy of speech therapy (e.g., guidance, therapeutic techniques, airway protection and maneuvers, orofacial myofunctional and voice exercises, and diet introduction) on improving early progression of oral intake patients with post-extubation dysphagia [80]. However, the European Stroke Organization and the European Society for Swallowing Disorders guidelines report low to moderate quality of evidence for treatment options such as dietary interventions, behavioral swallowing treatment including acupuncture, exercises, nutritional interventions, oral health care, different pharmacological agents, and different types of neurostimulation treatment in patients with post stroke dysphagia [25]. Despite this, treatments are usually focused on dietary texture modification and postural changes or compensatory maneuvers rather than on interventions to improve swallowing function [78].

Swallowing function can be improved with targeted intervention. Respiratory muscle strength training, comprised of expiratory and inspiratory muscle strength training, is a therapeutic treatment with a growing body of evidence as to its efficacy [81]. Sapienza and Hoffman provide a comprehensive review of various RMST devices and protocols across a range of patient populations for targeted exercise of the expiratory and inspiratory muscles. This treatment has been shown to improve airway management including cough effectiveness, swallowing outcomes, and ventilator weaning.

Neurostimulation techniques are another burgeoning treatment modality showing promise. To date, many of these treatments show moderate efficacy. Promisingly, PES demonstrates a high level of evidence for acceleration of decannulation in tracheostomized stroke patients with severe dysphagia [25]. PES has also been shown to improve secretion management, swallowing function, return to oral diet and nutritional independence often leading to reduced hospital length of stay in diverse patient populations including both ICU and non-ICU groups [70,72,82-89]. (Table 4) An ongoing randomized controlled trial to evaluate the clinical utility of PES delivered post-extubation [72] is currently underway.

Although our multidisciplinary panel of critical care experts has proposed algorithms to assist with early identification and intervention of dysphagic ICU patients, there are several limitations. First, our panel only consisted of eleven experts from three European counties and may not be representative or translatable to other countries. While many of our experts have worked across multiple institutions and represent a diverse range of specialties involved in the management of patients with dysphagia, we recognize key dysphagia management team members, including ICU nurses and dieticians, were not included in our expert group. Next, recommended instrumental assessment techniques and proposed therapies may not be available in all regions. However, the purpose of this article is to raise the awareness of dysphagia and promote best clinical practice. Lastly, the recommendations have the potential for a selection bias based on the personal experience of the expert panel or the lack of evidence in the literature review. A more systematic approach is needed to address these issues.

5. Conclusions

Given the lack of robust scientific evidence, we have developed and propose two clinical management algorithms for use by multidisciplinary teams to improve early systematic detection and effective management of dysphagia in extubated and tracheostomized ICU patients. The current treatment options are limited but newer modalities like neurostimulation have the potential to greatly improve patient outcomes.

Authors' contributions

Rudolf Likar: Conceptualization. Rainer Dziewas and Joerg C. Schefold: Methodology. Florence Boulmé and Anne Groves: Writing – original draft. All Authors: Writing – review and editing. Rudolf Likar and Markus Köstenberger: Supervision.

All authors have been involved in the writing of the manuscript at draft and at any revision stages; they have read and approved the final version of the manuscript.

Ethics approval and consent to participate

Not applicable.

Consent for publication

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JCS reports that Phagenesis, LTD is the sponsor of the randomized controlled clinical PHINEST trial (NCT03840395). This ongoing clinical study is investigating pharyngeal electrical stimulation in ICU patients and JCS is the principal investigator of this trial.

Data availability

Not applicable.

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